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Memo

DATE: *June 18, 2004*

TO: RHIC E-Coolers

FROM: *Ady Hershcovitch*

SUBJECT: **Minutes of the June 18, 2004 Meeting**

Present: Ilan Ben-Zvi, Andrew Burrill, Rama Calaga, Xiangyun Chang, Yury Eidelman (ORNL & BINP Novosibirsk, Russia), Alexei Fedotov, Wolfram Fischer, Ady Hershcovitch, Animesh Jain, Dmitry Kayran, Jorg Kewisch, Vladimir Litvinenko, Derek Lowenstein, William Mackay, Nikolay Malitsky, Christoph Montag, Thomas Roser, Dejan Trbojevic, Jie Wei.

Topics discussed: Presentation to NSAC & JLAP Science and Technology Review, INTAS Collaboration Meeting.

Presentation to NSAC & JLAP Science and Technology Review: Thomas opened the meeting by reporting that the RHIC electron beam cooling plan presentation to the Nuclear Science Advisory Committee (NSAC) seems to have gone well although the committee's report has not been completed. At Jefferson Lab, JLAB reported on progress in their FEL program to the Science and Technology review. Some of their results have significant implication on our program.

Beam breakup studies at the 10 kW FEL upgrade at JLAP have direct bearing on our program. Theoretical and experimental studies on their 145 MeV FEL are in very good agreement. It is very encouraging, since it boosts confidence in our theoretical calculations and simulations. Calculations predicted two unstable modes in their new cavity for electron beam currents of about 3 mA. The modes were identified experimentally. By changing the phase advance and by passive damping of HOMS, the instabilities were damped and the electron beam current was raised to 5 mA (and a 6 kW infrared power was reached). Very encouraging!

Ilan and Vladimir pointed out that their method can help reduce but, not eliminate both instabilities. Thomas said that in their case, there is only one cavity. It is easier to eliminate instabilities in one cavity than in a multi-cavity system.

INTAS Collaboration Meeting: Alexei reported on the INTAS E-Cooling dynamics meeting which took place in Kiev, Ukraine, during May 28-30, 2004. INTAS is a European electron beam cooling collaboration. The collaboration was setup to support future cooler storage rings at GSI (HESR, FAIR projects) and others worldwide. Goal of present projects is detailed understanding of high-energy cooling and long-term collective phenomena of cooled beam. To that end, the projects are now focusing on:

1. Develop analytic models and simulation tools to study various aspects of high-energy cooling, accounting for relevant heating processes.
2. Study collective phenomena in cooled beams.
3. Perform experiments to benchmark physics models and simulation codes being developed.

INTAS project teams and are GSI & TEMF, Darmstadt and FZ, Julich Germany, TSL, Uppsala Sweden ITEP, Moscow and JINR, Russia and University of Kiev, Ukraine. One near term objective is for INTAS, BNL and our collaborators to set up a joint computer code library (as early as this fall).

The theoretical work done by the INTAS teams basically follows our lead. However, during the next two years, the collaboration plans to conduct benchmark experiments. At the end of the presentation Alexei showed experimental measurements of the time evolution of longitudinal beam profile in CELSIUS as a consequence of IBS and due to cooling.

Below is a copy of Alexei presentation.

Following the presentation, a discussion ensued regarding our need for experiments (which everyone agrees to) and how to proceed. CELSIUS seems to be the choice machine. Ilan suggested doing two sets of experiments: a limited (in goals) experiment during free machine time to give us experience with the machine followed by a dedicate experiment. Dejan pointed out that at CELSIUS the magnesium beam is only partially stripped and therefore the physics is different (there is some “self-cooling” due to decay of excited ions). Using protons is one way of circumventing the problem.

INTAS E-Cooling dynamics meeting

(Kiev, Ukraine, May 28-30, 2004)

ITAS project "Advanced beam dynamics"

Support of future cooler storage rings at GSI (HESR, FAIR project) and worldwide.

New projects require detailed understanding of high-energy cooling and long-term collective phenomena of cooled beam.

Goal of the project:

1. Develop analytic models and simulation tools to study various aspects of high-energy cooling, accounting for relevant heating processes.

- Study collective phenomena in cooled beams
- Perform experiments to benchmark physics models and simulation codes being developed.

INTAS project teams

- GSI, Darmstadt (O. Boine-Frankenheim et al.)
- FZ, Julich (A. Lehrach et al.)
- TEMF, Darmstadt (T. Weiland et al.)
- TSL, Uppsala (V. Ziemann et al.)
- ITEP, Moscow (P. Zenkevich et al.)
- JINR, Dubna (I. Meshkov et al.)
- Univ. of Kiev, Ukraine (I. Kadenko et al.)

First day agenda

9.00 Beam dynamics for the international 'FAIR' project at GSI
O. Boine-Frankenheim, GSI

9.45 Status of the design work for the HESR
A. Lehrach, FZ Jülich

HESR e-cooler: up to 8 MeV electrons, 1A
solenoid: L=30 m, 1-5 KG

10.15 Coffee break

10.40 Electron cooling dynamics, IBS and simulation for RHIC
A. Fedotov, BNL

11.30 Electron cooling: Physics models and experimental verification
A. Sidorin, Dubna

12.15 Some peculiarities of electron cooling at low energy, results from HIMAC
I. Meshkov

12.45 Lunch break

14.00 Intrabeam scattering: 'Detailed' physics models and experimental verification
P. Zenkevich, ITEP

14.45 Scaling laws for equilibrium beam parameters in cooler rings
R. Hasse, GSI

15.45 Beam-target interaction in COSY
A.Lehrach

16.15 Beam-target interaction: Physics models
V. Ziemann

17.00-18.00 Open discussion

Second day agenda

8.45 Software development and modeling for nuclear physics applications
Igor Kadenko, Uni. Kiev

9.15 Software library issues
O. Boine-Frankenheim, GSI

10.00 Coffee break

10.30 Status and future plans for the BETACOOL code
A. Smirnov, Dubna

11.00 The BOLIDE interface for numerical applications
G. Trubnikov, Dubna

11.30 Status and future plans for the PTARGET code
A. Dolinskii, GSI/Kiev

12.00 Lunch break

13.15 Experimental plans
V. Ziemann, Uppsala

14.15 Distribution of the work within the teams: Short reports of the team leaders

15.00-16.30 Discussions

Highlights

Simulations:

Presently INTAS can use codes "BetaCool" and "PTarget" (similar to SimCool) plus MOCAC code (dedicated to IBS calculations).

- **Start using new version of BetaCool which is benchmarked vs SimCool (at BNL) for HESR studies**
- **Extract various effects (like "cooling", IBS, etc. as maps and include them under joined library, like UAL)**

Collaboration with BNL:

- **New models in BetaCool are being developed and benchmarked vs SimCool for RHIC. BetaCool development continues for RHIC – latest developments will be used by INTAS.**
- **Plan to start integration under joined library at BNL already this Fall.**
- **Benchmarking of codes and experimental data.**

- To develop and improve theory/simulations experimental data will be collected and posted on project web site for benchmarking and discussions.

  - Also, constant communication between European teams (INTAS) and BNL plus HIMAC was proposed.

Time table of present INTAS project Phase 1 (2004-2006):

1. Theory and simulations: 2004-2005-04.01.2006
2. First benchmarking with experiments: 2004-2005
3. Study of collective dynamics of cooled beams: 2005-2006

Next meeting at Dubna (March 2005): Progress update on simulations/theory and first experimental benchmarking; planning further experiments.

Phase 2 (2006-) is possible

Other highlights

- Recent experiments at HIMAC (Meshkov)

  - relaxation between transverse and longitudinal temperatures

  - strong increase of T_longitudinal (despite expectations).

- Cooling above transition ay GSI (Boine-Frankenheim)

  - dedicated experiment to resolve previous conclusions from CERN

  - problems with stability

3. Detailed IBS (Zenkevich)

   - collision maps; 3-D F-P solvers

4. Scaling laws (Hasse)

   -fitting available data with some scaling formulas

- Experiments at CELSIUS (Ziemann)

  -planning benchmarking experiments

Planning experiments

Several experiments (proposed by BNL) to test some aspects of high-energy cooling were discussed:

1. Benchmarking of cooling force for small Cooling Log (scaled RHIC regime) and study transition from good magnetization to bad.
2. Dependence on solenoid errors, v_effective, etc.
3. Evolution of beam distribution under cooling and IBS before equilibrium is reached – core formation – direct impact on luminosity.

General agreement: Experiments 1 and 2 should be evaluated in detail but any type of "scaling" and deviation from standard operational condition (large cooling log, etc.) of low-energy coolers lead to uncontrolled beam behavior and whether any useful result can be obtained is not clear –

HOWEVER, due to their importance and possible valuable information for high-energy cooling such experiments should be attempted (2005 - 2006) – may require request for dedicated time.

What can be done in operational coolers:

1. Any standard experiment:

to benchmark simulations and cooling force calculation for typical regime of low-energy cooling (no "scaling") – seems to be not very relevant to high-energy cooling – but removing factor of 10 uncertainty just in cooling force for sure will help.

- Easy to do and extremely important for code benchmarking – gives confidence in used formulas but not directly relevant to high energy cooling.

2. Relevant to high-energy cooling:

Formation of beam core under cooling and IBS – transient beam profiles before before equilibrium between IBS and cooling is reached - direct impact on luminosity increase – benchmark various models presently being developed at BNL.

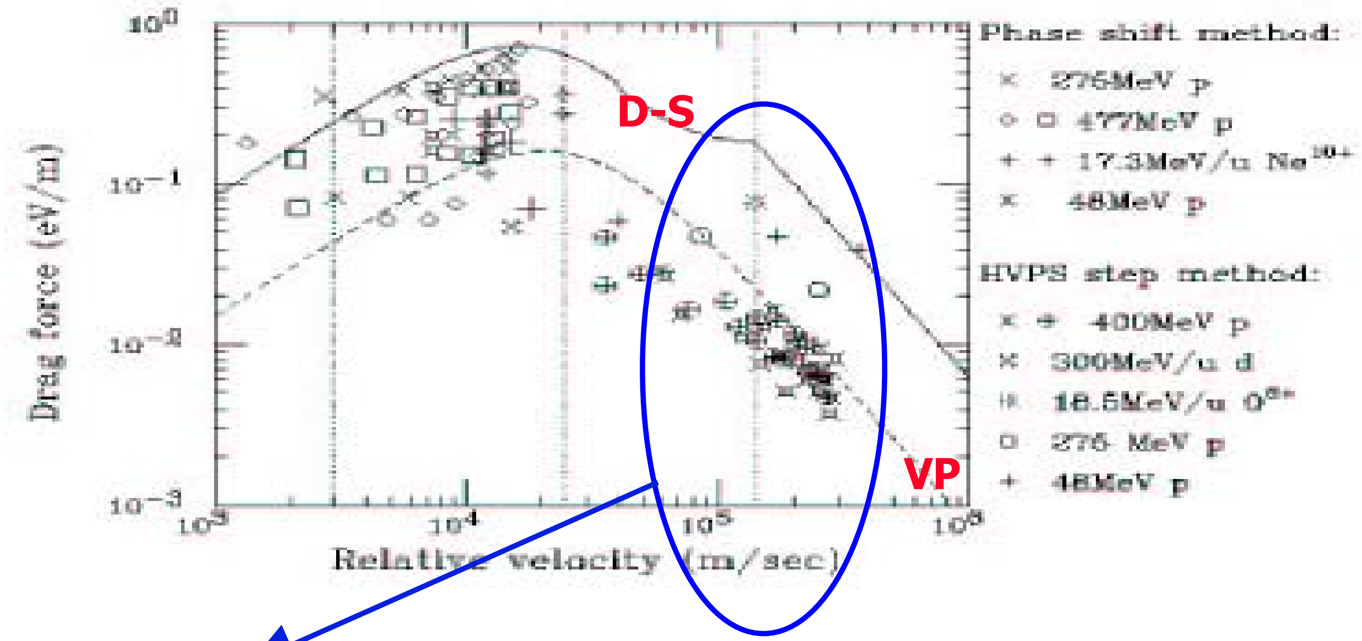
2.1) For longitudinal profile - was already demonstrated at CELSIUS – will be repeated for code benchmarking.

2.2) For transverse profile can be attempted with enhanced IBS/reduced cooling

- Has direct relevance for high-energy cooling - but will be difficult to benchmark with the codes (detailed IBS model are only in their development stage) – extremely important for benchmarking of IBS models for distribution under cooling

Benchmarking of longitudinal friction force – for standard regime of low-energy cooling with good magnetization

Y-N. Rao et al.: CELSIUS, Sweden'2001:



Longitudinal: Derbenev-Skrinskii formula overestimates cooling force by factor of 10; V. Parkhomchuk agrees reasonably well.

Evalution of longitudinal beam profile under cooling and IBS at CELSIUS – experimental measurements